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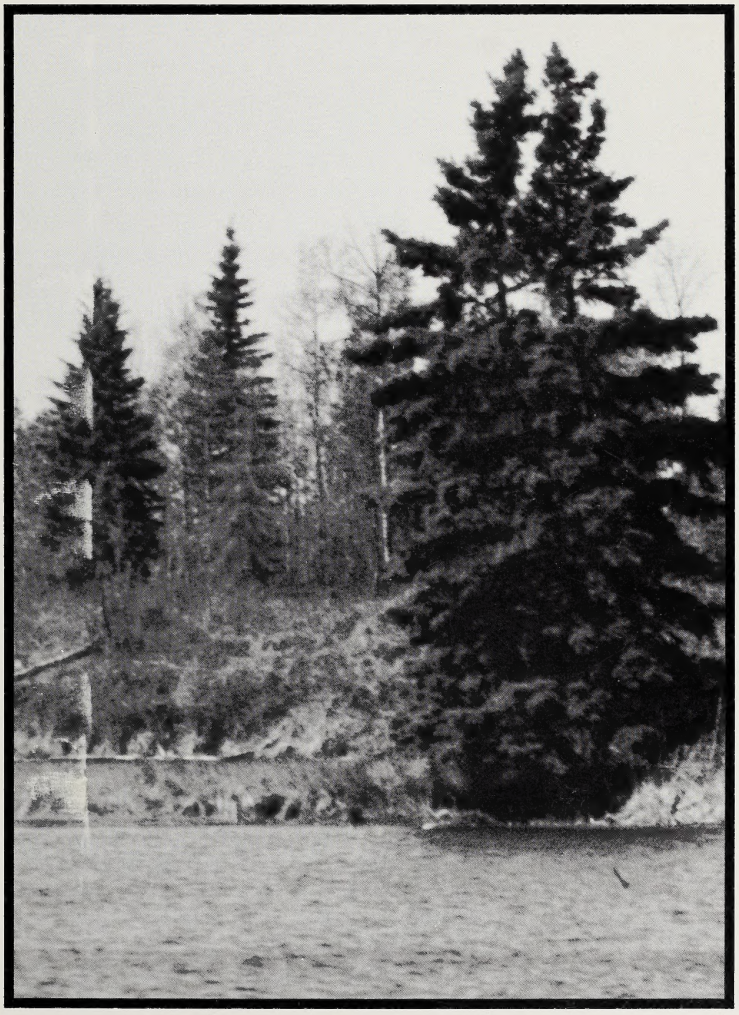

Module 6

Environmental Quality

Distance Learning

Alberta EDUCATION

CANADIANA

SEP 15 1992

Science 9

Module 6

ENVIRONMENTAL QUALITY

Science 9
Student Module
Module 6
Environmental Quality
Alberta Distance Learning Centre
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Welcome to Module 6!

We hope you'll enjoy your study of Environmental Quality. To make your learning a bit easier, a teacher will help guide you through the material.

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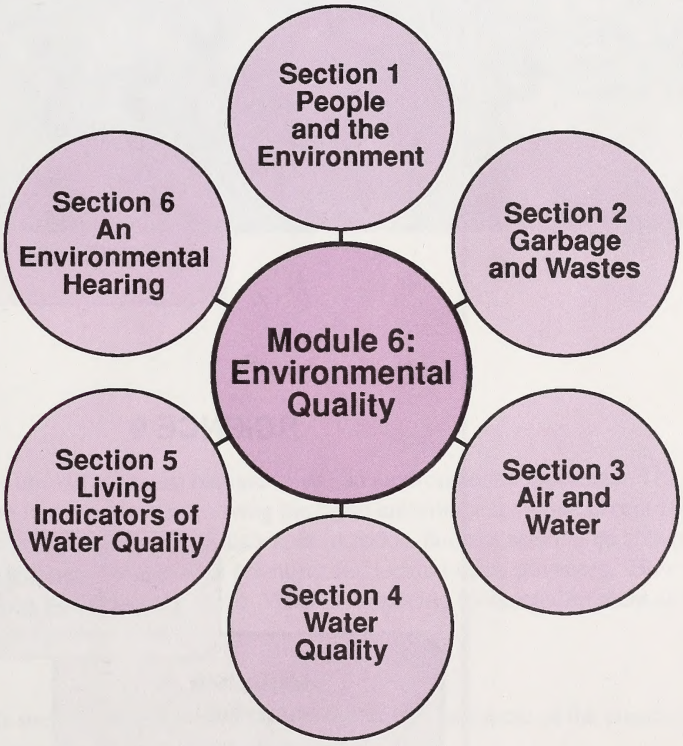
OVERVIEW

The environment is a subject that you hear about or read about almost every day. When the topic is the environment, many viewpoints are expressed. How can you decide which viewpoint or opinion is the correct one? Is there only one correct viewpoint?

By considering perspectives and alternatives, and by evaluating the effects of actions and the decision-making process, you can develop a personal awareness of the human impact on environmental quality.

In this module you will be introduced to the idea of environmental quality and the role of science in monitoring that quality. You will learn that personal and public decisions regarding environmental quality are needed. These decisions should be backed up by knowledge about environments and environmental impacts. You will have an opportunity to look at the long-term and short-term impacts of human actions within different environments. You will consider air, water, and soil quality as environmental quality indicators. You will examine a sample of water the way that an aquatic biologist would, and you will play a realistic role in a mock environmental hearing.



Evaluation

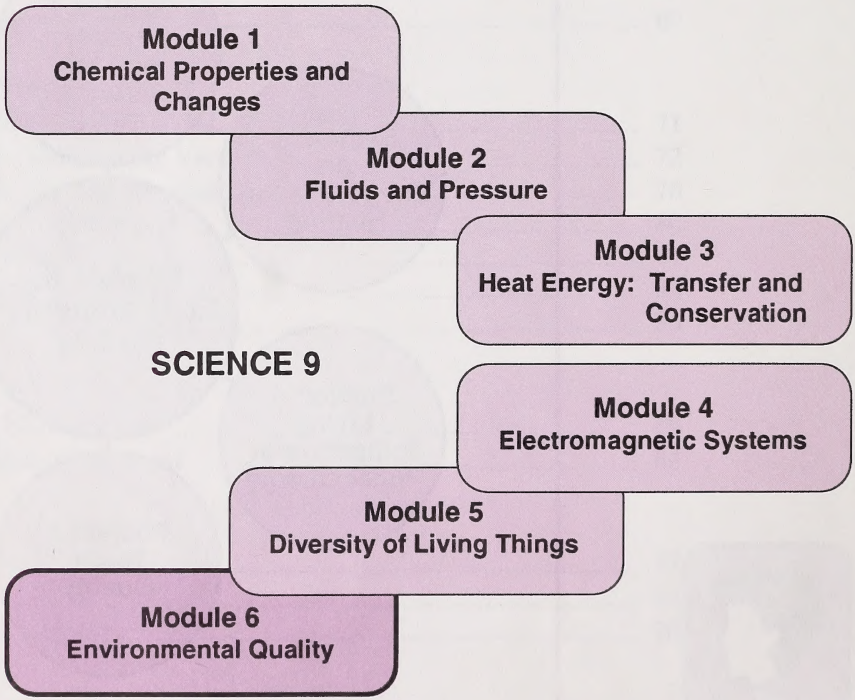
Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete five section assignments and a final module assignment.

The assignment breakdown is as follows:

Section 1 Assignment	**10%**
Section 2 Assignment	**15%**
Section 3 Assignment	**15%**
Section 4 Assignment	**10%**
Section 5 Assignment	**10%**
Final Module Assignment	**40%**
TOTAL	**100%**

Course Overview

Science 9 contains six modules. The module you will be working on is highlighted.



Section

1

People and the Environment

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Since the earliest times humans have had environmental problems. The major problem in the past was surviving the harsh environment. Now, except for occasional earthquakes, hurricanes, or tornados, humans seem to be able to control the environment with scientific and technological advances. How much control do humans really have? What is happening to the environment as Earth's human population grows?

In this section you will study population growth and some of the pressures that population growth puts on the environment.

Activity 1: Population Growth

There is a sign outside a town in Saskatchewan that says, "New York is big . . . but this is Biggar".

Whether you live in a small community like Biggar, or in a large Canadian city like Toronto, it is hard to visualize how many people live in New York because the population of New York is almost as large as the entire population of Canada!

Read pages 286 to 288 of your textbook. Then answer the following questions.

1. What has enabled people to make major changes to their environment?

_____

_____

_____

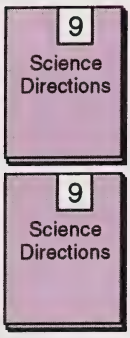
2. Explain what is meant by a "population explosion".

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 1.



Before beginning the following investigation, turn to pages 356 and 357 for a review of graphing.

Investigation

Refer to Part A of Activity 6-1 on page 289 of your textbook.

3. What is the problem for Part A of Activity 6-1?

_____

_____

4. Do the procedure for Part A. Plot your graph on the grid provided.

5. Do question 1 of Analysis.

6. Do question 2 of Analysis.

Check your answers by turning to the Appendix, Section 1: Activity 1.

Activity 2: Effects of Human Population Growth

In 1800 the earth's population was 1 billion. By the year 2000 there will be almost 6.5 billion people on the earth. Why has the human population increased so rapidly?

Read page 290 in your textbook for information about the growth of the human population.

1. What are two main factors responsible for the human population explosion?

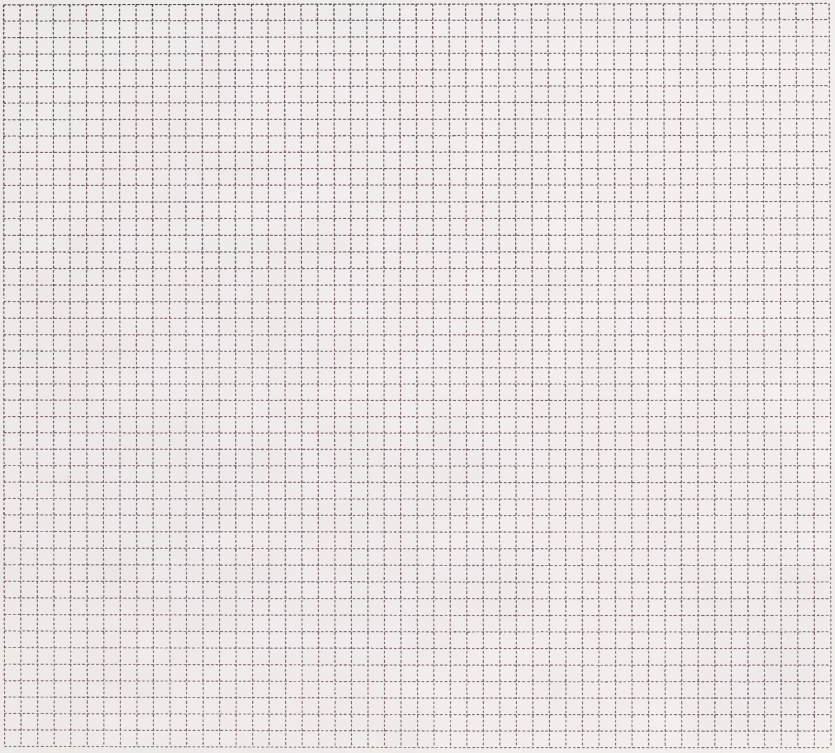
Check your answer by turning to the Appendix, Section 1: Activity 2.

9 Science Directions

Investigation

Refer to Part B of Activity 6-1 on pages 289 and 290 of your textbook.

2. Do the procedure for Part B. Plot your graph in the grid provided.



9 Science Directions

3. Do question 1 of Analysis on page 290 of your textbook.

4. Do question 2 of Analysis.

5. Do question 3 of Analysis.

6. Do question 4 of Analysis.

In this investigation you have discovered that people are moving towards the cities.

Science Directions 9

Read page 291 of your textbook. Then answer the following questions.

7. Define *urbanization*.

8. What are the two major impacts of a densely populated city on a relatively small area?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Activity 3: Researching an Issue

Identifying issues and concerns regarding environmental quality are among the skills which you will need to develop for this module and for your future participation in the democratic process.

Read pages 292 and 293 of your textbook. Then answer the following questions.

1. Define the word *issue*.

_____

_____

2. What makes an issue science-related?

_____

_____

3. Identify the appropriate viewpoints for Issue C. Remember that each issue has more than one viewpoint.

   a. ecological:

   _____

   _____

   _____

   b. economic:

   _____

   _____

   _____

   c. ethical/moral:

   _____

   _____

   _____

d. health-related:

e. political:

4. Should a viewpoint be considered right or wrong?

Check your answers by turning to the Appendix, Section 1: Activity 3.

Investigation

Refer to Activity 6-2 on page 294 of your textbook.

5. Do steps 1 and 2 of the procedure. Write the issue in the form of a statement.

6. Do step 3 of the procedure.

7. Do steps 4 and 5 of the procedure.

8. Do step 6 of the procedure.

9. Do step 7 of the procedure.

10. Do steps 8 and 9 of the procedure. Use the following table to compare viewpoints presented in at least two different articles.

Viewpoint	Article 1	Article 2	Article 3
Ecological			
Economic			
Educational			
Egocentric			
Ethical/Moral			

Viewpoint	Article 1	Article 2	Article 3
Health-related			
Recreational			
Political			
Scientific			
Technological			

Discuss your answers with your learning facilitator.

11. Do question 1. (b) of Analysis.

12. Do question 2 of Analysis.

13. Do question 3 of Analysis.

14. Do question 4 of Analysis.

15. Do Further Analysis question 5. This question may be used to complete a portion of your final module assignment. You should begin researching and collecting information on your topic and continue working on it throughout the rest of this module.

Share your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you learned to examine issues and determine the viewpoints expressed by various articles.

Use the following issue to answer the next question.

Issue: As the Labour Day weekend approaches, many people are getting ready to go camping for one last time this season. Some authorities want to close one of the largest campgrounds in Kananaskis Country because bears have moved into the lower altitudes to feed earlier than usual this year.

1. Match the viewpoint listed in Column A to the statements presented in Column B. Write the appropriate letters from Column A into the blanks before the statements in Column B.

Column A	Column B
a. ecological b. economic c. recreational d. political e. scientific	_____ This is the last long weekend of the summer and the last chance many people get to go camping before winter. _____ The bears need to move into the valleys to feed. This allows them to prepare for hibernation. _____ The bears belong in that environment and the campers are the intruders. Campers should be kept out. _____ If the campground is closed, the local store will have to lay off four of the seasonal workers before the long weekend. The workers were counting on the extra wages to pay for tuition at college next year. _____ If the campground closes, the Minister of Recreation and Parks will receive a lot of angry letters and phone calls.

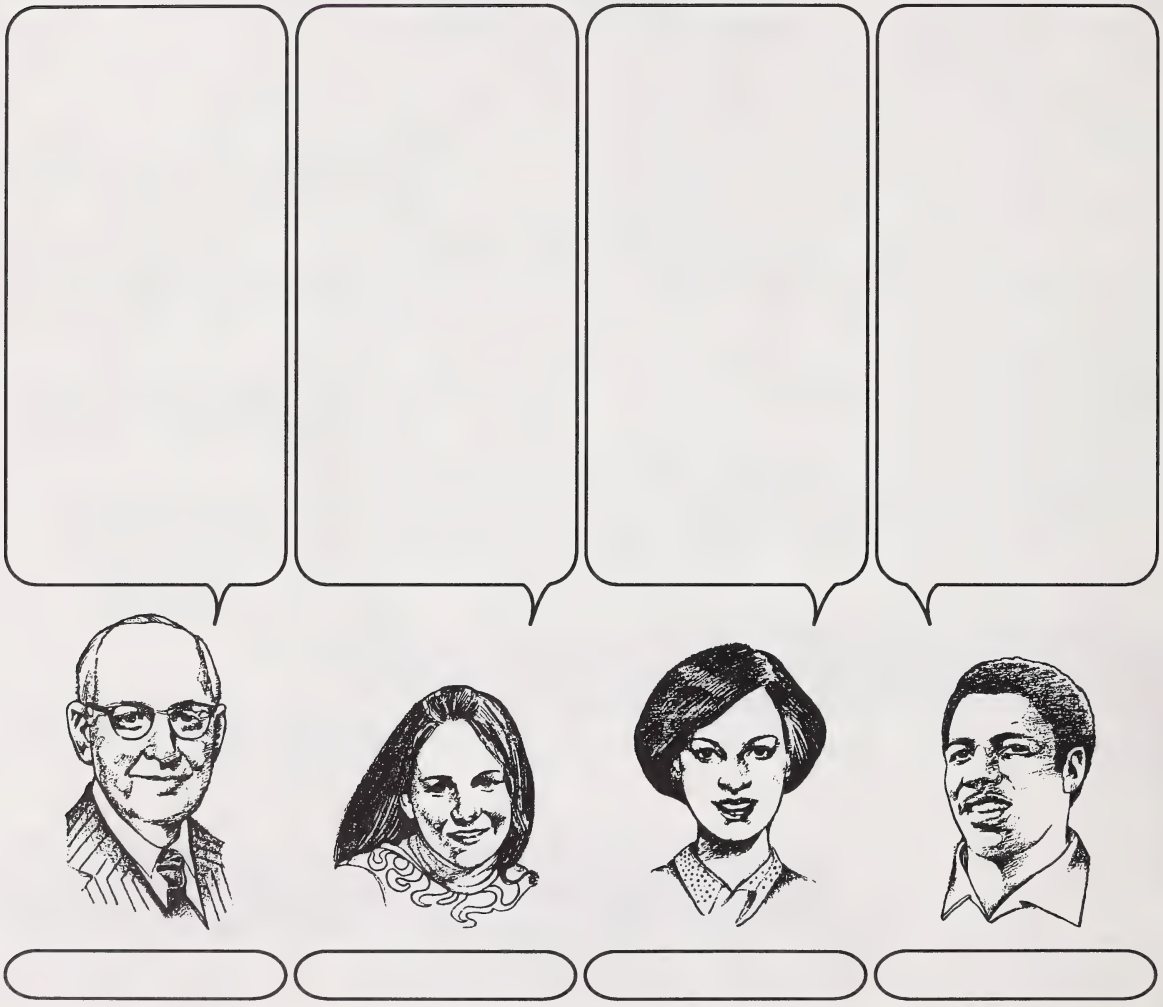
Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

9
Science Directions

Refer to page 293 in your textbook. Consider Issue E on the burning of coal. Use Issue E to answer the following question.

In the sketch below, write out a possible viewpoint statement in the dialogue bubble for each of the characters. Identify the viewpoint of each character in the box below each figure.



Discuss your answers with your learning facilitator.

Conclusion

In this section you learned about population growth, urbanization, and some of the problems associated with these trends. You also examined some issues and learned how to consider different viewpoints. You should also have started to collect information from the media (newspapers, magazines, TV, or radio) about a current issue of your choice. You may use this information for your final module assignment.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Section

2

Garbage and Wastes

When you toss a candy bar wrapper on the ground, it doesn't seem like such a big deal. There are always some wrappers on the ground around convenience stores. What difference does one more make? Have you ever seen what happens when all these wrappers collect along a fence after a wind storm? What would happen if the wrapper from every candy bar was thrown on the ground? Where would all this waste end up? What other kinds of wastes do people create? What happens to these other kinds of wastes?

In this section you will monitor and classify the wastes created by your activities, and you will look at methods of waste disposal. Finally, you will consider ways that you can influence the amount of solid waste that you throw away each day.

Activity 1: Measuring Waste

You may not have previously considered all the wastes produced in your home. On the other hand, if one of your chores includes taking out the garbage, you are probably aware of the amount of waste produced on a daily basis. In this activity you will actually measure the amount of solid waste that you produce in a two-day period.

9 Science Directions

Read page 296 of your textbook.

1. Define *solid waste.*

2. How much solid waste, on average, does each person in Canada discard per year?

3. How much solid waste, on average, does each person in Canada discard per day?

Check your answers by turning to the Appendix, Section 2: Activity 1.

4. Do you think that you produce more or less solid waste than the average Canadian? Explain your answer.

Check your answer with your learning facilitator.

Investigation

Refer to Activity 6-3 on page 297 of your textbook.

9 Science Directions

Caution: Always wash your hands after handling waste materials. Use plastic bags for any materials that are moist.

5. What is the problem for this investigation?

6. How many bags do you intend to use for this activity?

7. List three factors that might influence your results.

Follow steps 1 to 3 of the procedure outlined in the textbook.

8. Record each type of waste in the space provided. Rank each type of waste as described in step 4 of the procedure.

9. Do questions 1 and 2 of Analysis.

   Textbook question 1. (a):

   Textbook question 1. (b):

   Textbook question 2:

Discuss your answers with your learning facilitator.

Activity 2: Waste Disposal

You may wonder how the study of garbage can be called a science. You may in fact wonder who wants to study garbage at all! The issue of waste disposal can be considered from many viewpoints. Recall that the scientific viewpoint involves knowledge that is obtained by objective observation and experimentation. It is only through scientific study that you can put forward a scientific viewpoint.

Read pages 298 to 300 in your textbook. Then answer the following questions.

1. What is a sanitary landfill site?

   _____

2. What is the difference between wastes that are biodegradable and wastes that are non-biodegradable?

   _____

   _____

3. What is an important consideration in choosing the site for a sanitary landfill?

   _____

   _____

4. Why do some materials that are not dangerous while they are being used become dangerous when they are discarded as wastes?

5. What dangers do these materials present to the environment?

9 Science Directions

Read pages 301 and 302 in your textbook.

6. Write a short paragraph which describes how individuals and communities can reduce the volume of solid waste that they produce.

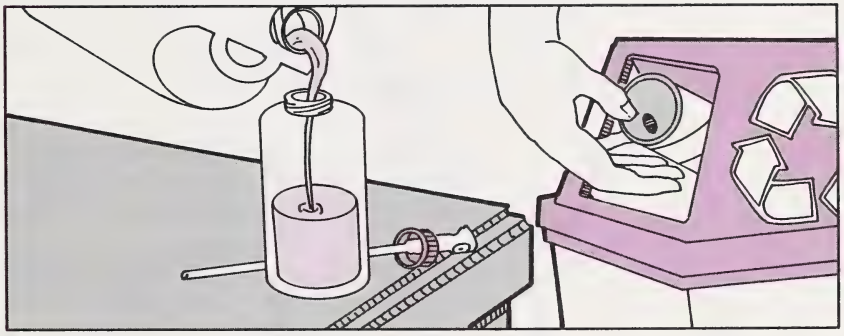
Check your answers by turning to the Appendix, Section 2: Activity 2.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you studied different methods of waste disposal.



1. Describe the four Rs of waste management and give an example of how you could use each method.

   a. reduce

   _____

   _____

   _____

   b. reuse

   _____

   _____

   _____

   c. recycle

   _____

   _____

   _____

d. recover

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

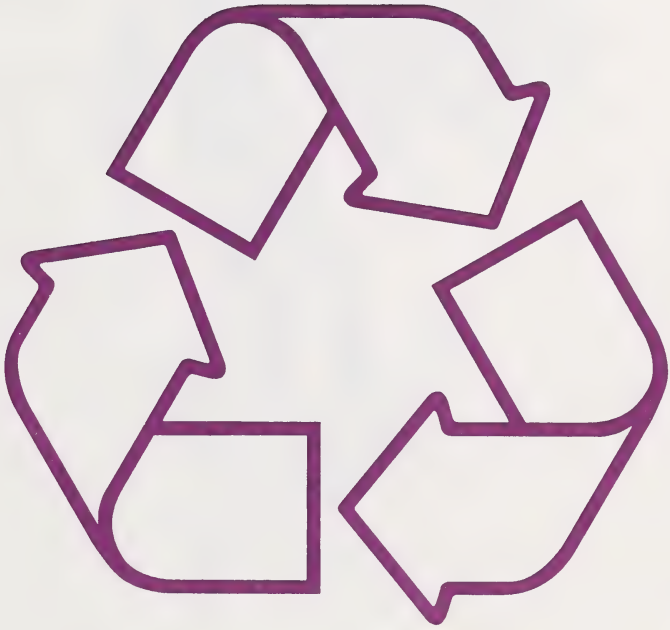
Now that you have closely monitored the solid waste that you have produced in a two-day period, consider how you could apply each of the four Rs of waste management to reduce the production of these types of wastes.

Write a short paragraph describing your proposals.

Check your answer by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you monitored and classified the solid waste that you produced in a two-day period. You looked at methods of waste disposal and some of the problems associated with waste disposal. Finally, you considered ways in which society and individuals can reduce the amount of solid waste they produce.



ASSIGNMENT

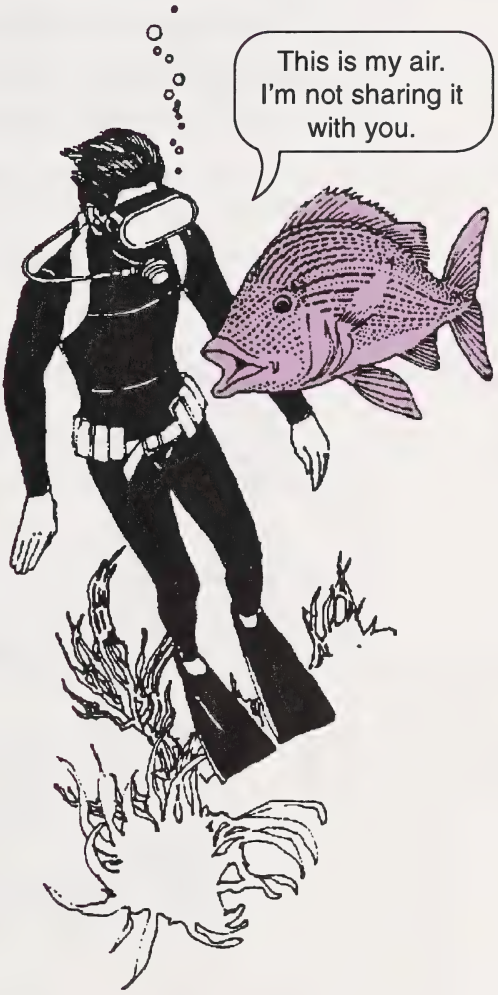
Turn to your Assignment Booklet and do the assignment for Section 2.

Assignment Booklet

Section

3

Air and Water



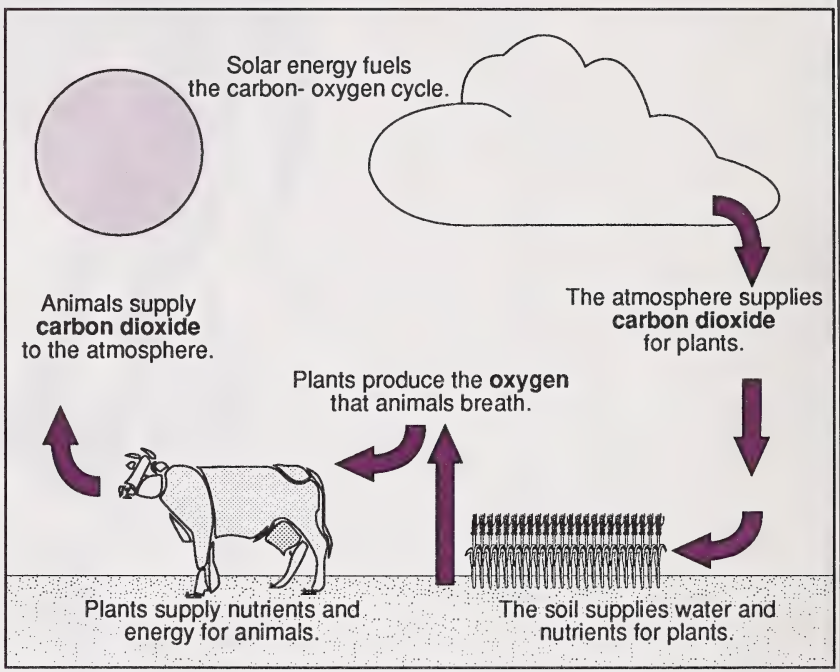
The air that you are breathing right now has been shared by every living thing on Earth since the beginning of time. In fact, the air has also been shared by automobiles and industrial plants. Even the compressed air that divers use has been shared and recycled. Since air and water are recycled naturally, you have no choice but to share both.

In this section you will identify some of the indicators of air quality and discover how pollutants can negatively affect the quality of the environment.

Activity 1: Pollution in the Air

When life is in balance on Earth, the producers (plants) use carbon dioxide, nutrients, and water to make oxygen and store energy as food. The consumers (animals and other organisms) do not make their own food. They use the nutrients, energy, and oxygen supplied to them by the plants.

Living plants make carbon dioxide and recycle nutrients and water. This is called the carbon-oxygen cycle.



Scientific studies have found evidence that this cycle has kept the percentage of oxygen in the atmosphere at about 21% for many millions of years. However, during the last two centuries, the activities of humans may have upset this balance. In addition, many human actions lead to other waste materials becoming part of this cycle.

9 Science Directions

Read pages 304 to 306 in your textbook. Then answer the following questions.

1. In what way is Earth like a spaceship?

_____

_____

_____

2. Why was the word *smog* not used until the late 1800s?

_____

_____

Investigation

9 Science Directions

Refer to Activity 6-4 on page 306 in your textbook.

3. Complete questions 1 to 4 from this activity.

Textbook question 1:

Polluting Gas	Major Source
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Textbook question 2:

_____

_____

Textbook question 3:

_____

_____

Textbook question 4:

Check your answers by turning to the Appendix, Section 3: Activity 1.

Activity 2: Acid Rain

Pollution in the air can cause other problems. Some air pollution can come back to Earth in the form of acid rain.

ALBERTA RESEARCH COUNCIL

9 Science Directions

To learn more about acid rain, read pages 308 to 311 in your textbook.

1. What are the two main pollutants that cause acid rain?

2. What is the pH of acid rain?

3. What are three main effects of acid rain?

4. Why is acid rain less destructive in some areas than in other areas?

9
Science Directions

5. List three measures that have helped reduce air pollution in the last twenty years.

_____

_____

_____

_____

_____

_____

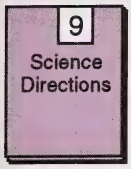
Check your answers by turning to the Appendix, Section 3: Activity 2.

Activity 3: Pollution in the Water

When you think about having a cold, thirst-quenching glass of water, does it make a difference to you whether you are taking the water out of a tap, a well, a clear mountain stream, or a stagnant slough?

When the pioneers were looking for drinking water in the desert, they would search for water that was crawling with insect larva. They believed that if insects lived in the water, it must be drinkable. They knew that water without insects may look clean and pure, but it may contain contaminants that could kill them.

You know from your studies that, like the arsenic in some desert springs, many pollutants cannot be seen.



Read pages 312 to 315 in your textbook.

1. What are four ways that pollutants can reach lakes and rivers?

_____

_____

_____

_____

2. Define the following terms.

   a. sewage: _____

   _____

   b. effluent: _____

   _____

   c. sludge: _____

   _____

3. Explain what each of the following processes do to waste water.

   a. primary sewage treatment:

   _____

   _____

   b. secondary sewage treatment:

   _____

   _____

c. tertiary sewage treatment:

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section, you learned about both air pollution and water pollution.

Refer to the graphs on page 306 and 307 of your textbook. Use these graphs to answer the following questions.

1. Which category, vehicle exhausts or industrial processes, is the greatest source of pollution on three of the five graphs?

   _____

   _____

2. Which natural process is found on three of the five graphs?

   _____

   _____

3. Which of the sources of air pollution is contributed to directly by individuals?

   _____

   _____

4. If there is an immediate danger of extreme air pollution, which would be the easiest solution: reducing vehicle exhaust, or reducing emissions from industrial processes? Why?

_____

_____

_____

_____

_____

_____

_____

_____

5. Match the type of pollutant in Column A with the source of pollution in Column B. Place the letter from Column A in the line provided in Column B.

Column A	Column B
a. disease-causing agents	_____ agriculture, forestry, mosquito control
b. carbon compounds	_____ poorly treated domestic sewage
c. water-soluble acids and salts	_____ paper-making plants
d. water-soluble poisons	_____ uranium mining
e. plant nutrients	_____ food-processing industries
f. sediment and suspended undissolved matter	_____ electrical power plants
g. radioactive substances	_____ irrigation
h. heat (from water used as a coolant)	_____ construction

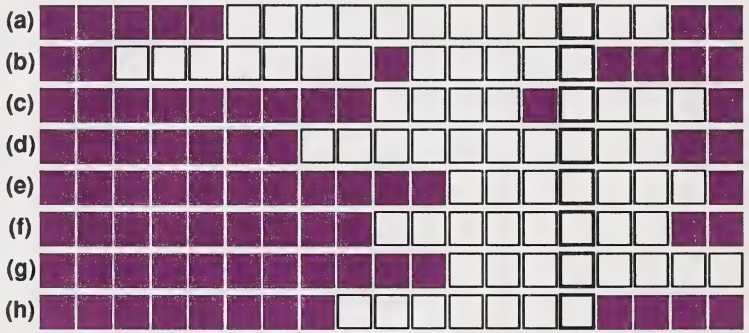
Check your answers by turning to the Appendix, Section 3: Extra Help.

9
Science Directions

Enrichment

Refer to page 328 of your textbook.

1. Do Checkpoint question 1.



Hidden word: _____

Definition: _____

_____

_____

_____

9 Science Directions

2. Compare the maps shown on pages 309 and 310 of your textbook. One map shows the regions of North America which are the most sensitive to acid rain. The other map shows the regions receiving acid rain. Write a brief paragraph explaining why acid rain may be a more sensitive issue in some parts of Canada than in other parts of the country.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you identified some of the indicators of air quality and discovered how pollutants negatively affect the quality of the environment.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

Section

4

Water Quality

[1]

The small organisms that you find in a sample of pond water live in a special environment. It has just the right amount of oxygen and an entire food chain that contains the tiniest microbes and visible plants and animals. As you examine a small confined sample of water over several days, you might see changes in this small ecosystem. What do you think these changes might be?

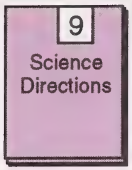
The living things in the water and the completeness of the food chain can tell you a lot about the quality of the water. What other factors might affect water quality?

In this section you will learn how to make measurements to evaluate water quality. You will practise these techniques while evaluating a sample of water from your own locality. The data that you collect in this way may even be presented as evidence at an environmental hearing!

[1] Alberta Environment for the photographs taken by Dan Stoker, taken from *Environment Views Magazine*, June 1988. Reprinted by permission of Alberta Environment.

Activity 1: Water and Food Processing

You will recall that one person alone does not have a noticable effect on the environment. It is when there are large numbers of people all doing the same thing that there can be an effect on the environment.



Read pages 316 and 317 in your textbook. Then answer the following questions.

1. How is water used in the processing of carrots?

2. Describe the technological problem that had to be solved for the carrot-processing industry?

3. In what ways are there additional benefits from a technological solution to this problem?

4. Play the role of each of the following people being interviewed for a national newsmagazine. Briefly describe the problem and the solution to the potato chip dilemma.

   a. potato chip producer:

b. mayor of the city:

c. local farmer:

Check your answers by turning to the Appendix, Section 4: Activity 1.

Activity 2: Dealing with an Environmental Problem

This activity is centred around a case study described in your textbook. Rapid Steps is a growing community with a growing water problem. As you will see, solutions to an environmental problem are often made difficult by the conflicting interests of many different people. In such a situation science has an important role to play.

A scientist must gather data to determine the nature of the problem. Technologists and engineers will use this information to design pollution control systems. These systems must then be evaluated and modified to ensure that they are effective. However, the monetary and social costs of some solutions often make them a source of public debate at environmental hearings.

Should this person be made to pay for the clean up? What do you think?

9 Science Directions

Read pages 318 to 321 of your textbook. Then answer the following questions.

1. List several ways that you use surface water at least once per week.

_____

_____

_____

2. a. What is the current population of Rapid Steps?

_____

b. What will the population of Rapid Steps be in twenty-five years?

_____

3. What is the main complaint of the people who live downstream from Rapid Steps?

_____

_____

_____

4. Why is this a worry for the politicians from Rapid Steps?

5. Suppose tax money must be used for a cleanup. What are three additional things that tax money is needed for?

6. What appear to be the choices of the fertilizer plant?

7. In what way does the local detergent plant have an interest in this controversy?

8. What is the suggestion of the agriculturalist to solve the dilemma?

Check your answers by turning to the Appendix, Section 4: Activity 2.

In the next several activities, you will play the role of a scientist looking for the answers to these questions:

- What was the Rapid River like before the problem started?
- What is the Rapid River like now?
- How has the Rapid River changed?

In order to answer these questions, you need to gather, compile, and analyse data.

The data in the following table was collected at an earlier stage in the development of Rapid Steps. In the following activities, you will collect the current information. Complete the following table as you gather the current readings for undissolved solids, phosphate content, and dissolved oxygen in the Rapid River.

	Undissolved Solids (Suspended Solids)		Phosphates		Dissolved Oxygen	
	Previous Reading (mg/L)	Current Reading (mg/L)	Previous Reading (mg/L)	Current Reading (mg/L)	Previous Reading (mg/L)	Current Reading (mg/L)
Site 1	20.0		10.0		10.0	
Site 2	30.0		12.0		10.0	
Site 3	40.0		12.0		8.0	
Site 4	50.0		15.0		7.0	
Site 5	40.0		11.0		10.0	

9 Science Directions

Activity 3: Measuring Suspended Solids

When water looks cloudy or muddy, it is often a type of mechanical mixture containing undissolved solids.

Read pages 322 and 323 of your textbook. Then answer the following questions.

1. Define *turbid.*

2. What level of sewage treatment is supposed to remove the suspended solids?

3. Why was it necessary for the biologist to take samples from a series of sites above and below the sewage treatment plant?

9 Science Directions

Refer to Activity 6-5 on page 324 of your textbook.

4. Do questions 1 and 2 of Analysis.

   Textbook question 1:

   Textbook question 2:

Record the current data for undissolved solids in the appropriate column of the table at the end of Activity 2. Examine both sets of data.

5. Why does the amount of undissolved solid seem to increase as you go further downstream?

_____

_____

_____

_____

6. Why might the amount of undissolved solid be slightly lower at Site 5 than at upstream sites?

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 4: Activity 3.

Activity 4: Identifying Phosphates

Part A is optional, but Part B must be done by all students.

Part A (Optional)

Recall that a scientific viewpoint involves knowledge collected in an objective manner. A scientific investigation will help you determine if phosphates are present in water samples. However, you should obtain permission and special instructions from your learning facilitator before attempting the following investigation.

9
Science Directions

Investigation

Refer to Part A of Activity 6-6 on page 325 of your textbook.

Caution: This investigation must be done under the supervision of your learning facilitator. See your learning facilitator for the materials to be used for this investigation. Follow all safety precautions suggested by your learning facilitator.

Ammonium hydroxide can burn your skin. Your learning facilitator will provide you with a dilute solution of household ammonia to be used in this investigation. Handle it carefully and be sure to wear safety glasses, safety gloves, and a safety apron while doing this investigation.

1. What is the problem in this investigation?

_____

_____

2. List the equipment that is required for safety reasons.

_____

_____

_____

- Obtain the necessary equipment and materials from your learning facilitator.

3. Predict which samples will contain phosphates.

_____

_____

- Follow the procedure described in Part A.

4. What is the function of the ammonium hydroxide?

_____

_____

5. Do questions 1 to 4 of Analysis.

Textbook question 1:

Textbook question 2:

Textbook question 3:

Textbook question 4:

Share your answers with your learning facilitator.

End of Part A

Part B

6. Do questions 5 and 6 of Further Analysis.

   Textbook question 5:

   _____

   _____

   _____

   Textbook question 6:

   _____

   _____

   _____

The Greek letter μ (mew) is used as the metric prefix for *micro*. *Micro* means 10^{-6} in scientific notation, or the same as writing 0.000 001.

If you require additional review of metric prefixes, refer to page 344 of your textbook.

- Do Part B of Activity 6-6 on page 325 of your textbook.

7. Do questions 1 and 2 of Analysis.

   Textbook question 1:

   _____

   _____

   _____

   Textbook question 2:

   _____

   _____

   _____

Check your answers by turning to the Appendix, Section 4: Activity 4.

Activity 5: Oxygen in Water

You have learned that oxygen is important to most living things. The amount of oxygen found in water helps you determine the quality of the water.

Read page 326 in your textbook.

1. Explain the following terms:

   a. abiotic factors: _____

   _____

   _____

   b. biotic factors: _____

   _____

   _____

2. How much oxygen is required in the water to ensure that most organisms tha live in the water will be able to live there?

   _____

3. Explain what is meant by the units one milligram per litre (1mg/L)

   _____

   _____

Check your answers by turning to the Appendix, Section 4: Activity 5.

Investigation

Do Part A or Part B.

Do Part A if you are able to obtain a dissolved oxygen test kit. Do Part B if you are unable to obtain this kit.

9 Science Directions

Part A

Refer to Part A of Activity 6-7 on page 327 of your textbook.

Caution: Care is required when working with boiling water or steam. Do this investigation under the supervision of your learning facilitator.

- Follow steps 1 and 2 of the procedure. Allow your boiled water to cool, then do steps 3 to 6.

Note: When using the procedure outlined in your textbook, include any special instructions provided with the dissolved-oxygen kit you are using.

4. Record your data in the following table.

Sample	Dissolved Oxygen (mg/L)
1. tap water	
2. boiled water	
3. boiled, cooled water	
4. sample 3, shaken	
5. sample 3, shaken again	
6. sample 3, shaken third time	

End of Part A

Part B

5. Examine the information provided in the Appendix. Record the appropriate data in the table provided in question 4 of Part A.

End of Part B

6. Do question 2 of Analysis on page 327 of your textbook.

7. Write a statement to describe the effect of increased turbulence on the oxygen content of water.

8. Do questions 4 and 5 of Further Analysis.

   Textbook question 4. (a):

   Textbook question 4. (b):

Textbook question 5:

Check your answers by turning to the Appendix, Section 4: Activity 5.

Refer to Part B of Activity 6-7 on page 327 of your textbook.

- Record the current data for dissolved oxygen in the appropriate column of the table at the end of Activity 2.

9. Do questions 1 and 2 of Analysis.

Textbook question 1:

Textbook question 2:

Check your answers by turning to the Appendix, Section 4: Activity 5.

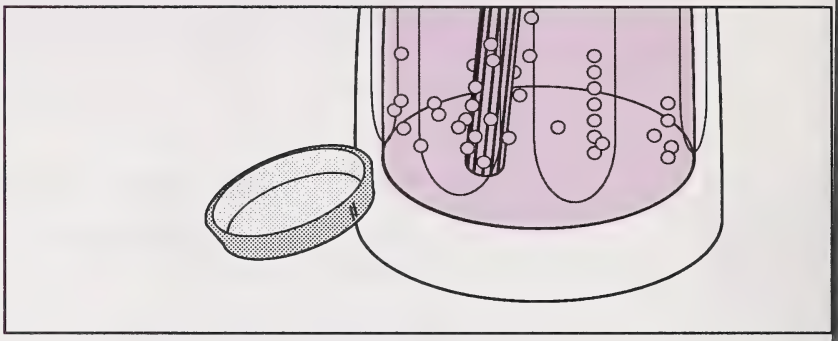
Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you may not realize that oxygen is both a part of the water molecule and a gas that can dissolve in water.

Water is a chemical compound made up of the elements hydrogen and oxygen in the ratio of two parts of hydrogen for every part of oxygen. You are probably familiar with the fact that water can change physically from a liquid to a solid or to a gas, but it always has the same chemical composition of two parts of hydrogen for every part of oxygen. Water also acts as a solvent for many other substances. Sugar or salt readily dissolves in water. Some gases also dissolve in water. Carbon dioxide can be dissolved in water to form a carbonated beverage.



You can see carbon dioxide coming out of solution as the fizz in pop after it has been opened. You have learned that oxygen also dissolves in water and is very important for aquatic organisms.

1. What happens to the carbon dioxide dissolved in pop when the drink is heated up and allowed to go flat?

   _____

2. Do you think that it is easier to dissolve a gas in warm or cold water?

   _____

3. What happens to the dissolved oxygen as you heat water to boiling?

   _____

4. Describe one way that oxygen could be lost from water in streams and rivers.

   _____

   _____

5. Describe one way that oxygen could be returned to the rivers and streams.

Check your answers by turning to the Appendix, Section 4: Extra Help.

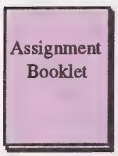
Enrichment

Find an article in a newspaper or a magazine which describes some positive steps taken by an industry to improve the environment by reducing the amount of wastes distributed to the air or water. Write a short paragraph which describes the major issues and how the company tackled the problem.

Share your answer with your learning facilitator.

Conclusion

In this section you learned that water quality can be tested for turbidity, phosphates, and dissolved oxygen. You learned that these very small measurements are made in units of milligrams per litre and micrograms per litre. In the next section you will see another way to collect data to measure water quality.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 4.

Section

5

Living Indicators of Water Quality

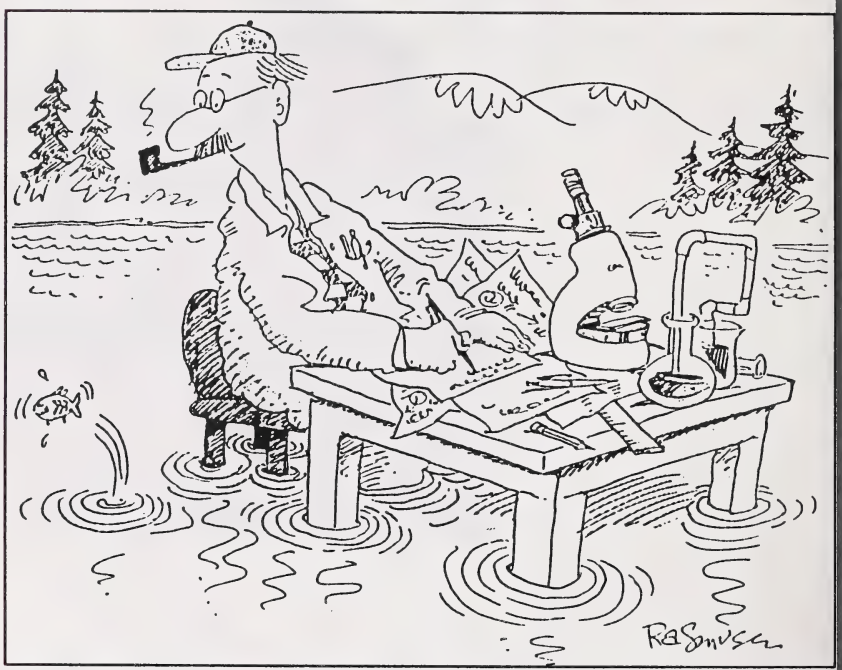
In a previous section you learned that the pioneers searching for water in the desert looked for the presence of insect larvae to tell them that the water was not contaminated. Today aquatic biologists monitor water quality by collecting and counting aquatic invertebrates in a body of water. Data collected by these scientists allows them to infer the level of pollution in the water. Studies have determined that there are three general groups of bottom dwellers; some organisms are tolerant of poor water quality caused by pollution, others are somewhat tolerant, and other organisms are not tolerant at all.

In this section you will learn to recognize some of the organisms that are used to indicate water quality. You will also learn about the sampling techniques used by aquatic biologists.

Activity 1: Life in the Water

Why do you think that some organisms are tolerant of the level of pollution and other organisms are not tolerant at all?

The amount of dissolved oxygen seems to be the critical factor. In the previous section you used a test kit to chemically determine the amount of dissolved oxygen in water. By finding certain organisms in a pond, river, or stream, you can infer that the oxygen level is sufficient for them to grow there.



Read pages 329 and 330 in your textbook. Then answer the following questions.

1. What is a general rule about the number of organisms and the cleanliness of the water?

[1] Alberta Environment for the cartoon by Gerry Rasmussen, taken from *Environment Views Magazine*, Sept./Oct. 1984. Reprinted by permission of Alberta Environment.

2. What is meant by the term *biological indicator*?

_____

_____

3. Explain in your own words how biological indicators are used.

_____

_____

4. Do you think that the data obtained from biological indicators is more or less reliable than the data obtained from chemical tests? Give reasons for your opinion.

_____

_____

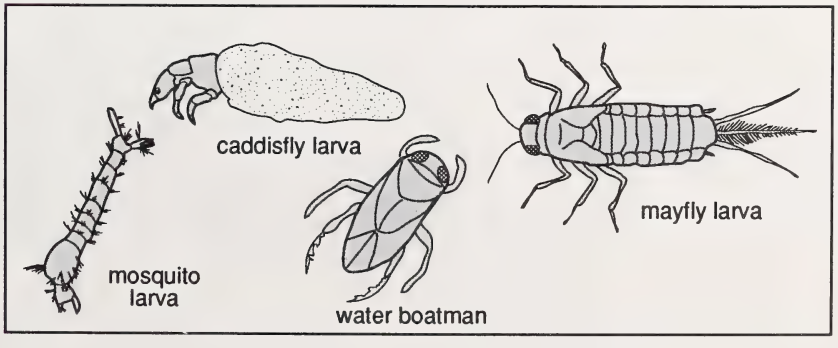
_____

_____

Check your answers by turning to the Appendix, Section 5: Activity 1.

Activity 2: Sampling Invertebrates

Environmental quality is directly related to the ability of an environment to support life.



In this activity you will look at the life in the water as an indicator of water quality. This may be accomplished by taking an actual sample of pond water from your area, or it might involve writing a description of how such a sample could be taken. Later, you will analyse a set of data to prepare a statement about water quality.

Investigation

Do Part A or Part B.

Do Part A if you are able to collect a sample of pond water and have the necessary materials. Do Part B if you are unable to obtain a sample of pond water or do not have access to the necessary materials.

Caution: Do not attempt to collect specimens alone. This should only be done with the supervision of your learning facilitator.

Part A

Refer to Activity 6-8 on page 331 of your textbook.

Follow the procedure for Part A of Activity 6-8.

If the number of organisms of one type seems to be too numerous for you to count, you may indicate qualitatively that there are more or less of them than other organisms.

You will find that it is easier to sort the organisms if you place them in a transparent dish on a piece of graph paper and do each square methodically.

Record your data in a table similar to the one provided.

Name of Organism	Number
Mosquito Larva	
Midge Larva	
Stonefly Larva	
Water Boatman	
Mayfly Larva	
Caddisfly Larva	
Leech	

1. Do questions 1 to 5 of Analysis in Part A on page 333 of your text.

   Textbook question 1:

   _____

   _____

   Textbook question 2:

   _____

   _____

   Textbook question 3:

   _____

   _____

   Textbook question 4:

   _____

   _____

Textbook question 5:

End of Part A

Check your answers by turning to the Appendix, Section 5: Activity 2.

Part B

Answer the following questions based on the procedure described in Part A of Activity 6-8.

2. Describe how you would collect and preserve a sample of invertebrates from the bottom of a river or stream.

3. Describe how you would analyse your sample to provide data on water quality.

9 Science Directions

4. Examine the data from Site 1 on Table 6-7 on page 333 of your textbook and make a statement about the water quality at this site.

_____

_____

_____

End of Part B

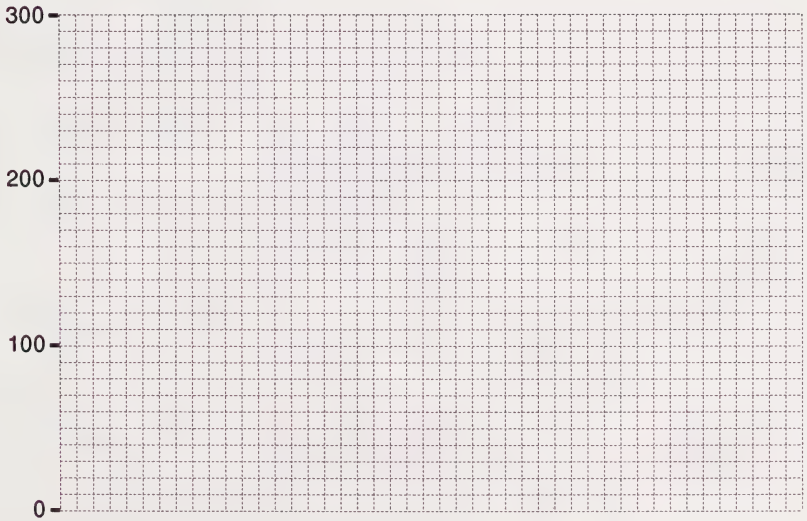
Check your answers by turning to the Appendix, Section 5: Activity 2.

9 Science Directions

Refer to Part B of Activity 6-8 on page 333 of your textbook.

5. Answer questions 1 to 5 of Analysis in Part B.

Textbook question 1:



Textbook question 2:

Textbook question 3:

Textbook question 4:

Textbook question 5:

Check your answers by turning to the Appendix, Section 5: Activity 2.

Follow-up Activities

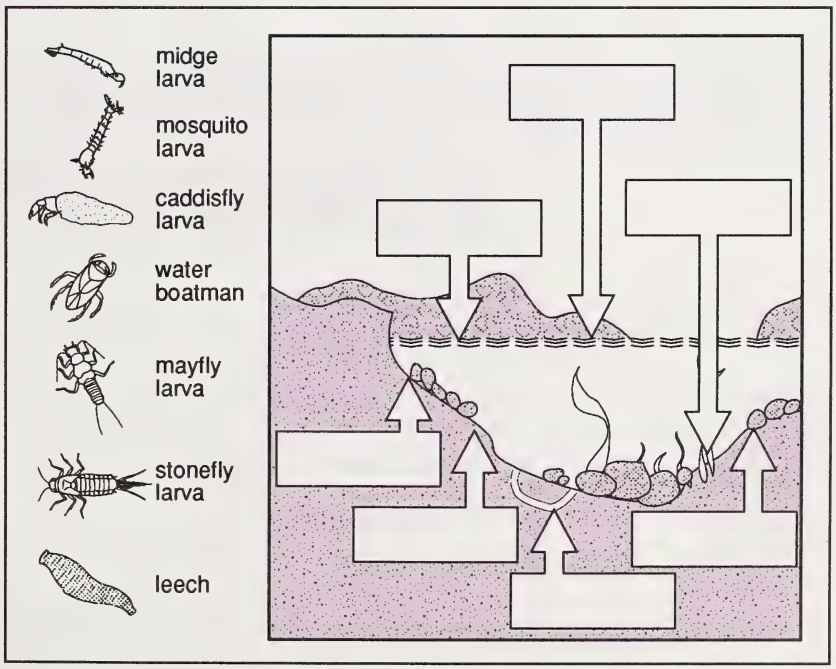
If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you learned that you can determine the quality of the water by examining what lives in the water.

Refer to Table 6-5 on page 330 of your textbook.

1. Match the organisms on the left with their habitats on the right. Write the names in the appropriate locations.



2. Three students were hiking through the forest when they discovered a small pond. One of the students picked up a rock and discovered a large number of leeches under it. They concluded that the oxygen concentration must be very low. However, one of the students suggested that they must also look to see if there were any Caddisfly larvae or Mayfly larvae in the water before deciding for sure.

   Explain why it is a good idea to check for Caddisfly larvae and Mayfly larvae first.

Check your answers by turning to the Appendix, Section 5: Extra Help.

Enrichment

Refer to the Extension of Activity 6-8 on page 333 of your textbook.

Do either question 1 or question 2.

1. Answer question 6 of Extension.

2. Answer question 7 of Extension.

Check your answers by turning to the Appendix, Section 5: Enrichment.

Conclusion

In this section you learned that some organisms can be used to indicate water quality. You also learned about sampling techniques used by aquatic biologists, and you have analysed the results of a sample study.

In the next section you will see how this information can be used in an environmental hearing.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 5.

Section

6

An Environmental Hearing

As you read about the dilemma regarding pollution in the Rapid River in previous sections, you should have noticed that there can be many different viewpoints on such an issue. Is there a method for dealing with environmental problems? How can science help to resolve some of the conflicts between different points of view?

In this section you will examine the public hearing process that is used to obtain input on environmental issues. You will discover that public hearings are part of a decision-making model that helps to identify issues, present data, help resolve different points of view, decide on an appropriate course of action, and evaluate the consequences of the actions that have been chosen.

Activity 1: Determining Viewpoints

Stakeholder: a person that has something to gain or lose, depending on the decisions made about a particular issue

The points of view expressed by different **stakeholders** can often make the real issues difficult to identify. Solving the fundamental issues for all parties is important in finding lasting solutions.

This activity presents a model to use when solving personal and societal issues.

The Decision-Making Model

- Identify the issues.
- Identify the alternatives.
- Research the issues.
- Reflect and decide.
- Take action.
- Evaluate the action and the decision-making process.

The decision-making model will be used in following activities as you try to resolve the problems of the Rapid River.

The city of Rapid Steps is considering upgrading its sewage treatment plant. Various viewpoints on the issue are presented in your textbook.

9
Science Directions

Read pages 334 and 335 in your textbook and consider which of the viewpoints listed on page 293 of your textbook each speaker is expressing.

1. After reading the viewpoints that are presented on pages 334 and 335 of your textbook, complete the following table.

Role	For/Against/ Neutral	Viewpoint	Summary of Reasons

Role	For/Against/ Neutral	Viewpoint	Summary of Reasons

2. Develop three to five questions that you could ask the participants in the environmental hearing. The questions may be general and addressed to all participants, or the questions may be very specific and addressed to one person. Indicate who should answer each question (e.g., To: all participants, or To: the fishing guide).

To: _____

Question: _____

_____

_____

To: _____

Question: _____

_____

_____

To: _____

Question: _____

_____

_____

To: _____

Question: _____

_____

_____

To: _____

Question: _____

_____

_____

Check your answers by turning to the Appendix, Section 6: Activity 1.

Activity 2: A Public Hearing

Scientific knowledge contributes to the environmental decision-making process. Personal decisions that you make can also affect environmental quality. One way you can demonstrate responsible action is by making a presentation at a public hearing on an environmental issue.

If you are part of a large class or group, you may be able to participate in a mock public hearing.

Refer to Activity 6-9 on page 336 of your textbook.

Based on your previous readings about the Rapid River, select one of the roles from the list as your personal position.

1. Which role have you chosen to prepare for?

2. Are you for, against, or neutral about spending tax money on this project?

3. Write your speech for the hearing. The speech must be approximately two minutes in length. Practise giving this speech in the role you have chosen. To be convincing, ensure that your timing is right!

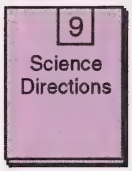
Present your speech to your learning facilitator.

4. Do questions 1, 4. (a), and 4. (b) of Analysis on page 337 of your text.

   Textbook question 1:

   Textbook question 4. (a):

   Textbook question 4. (b):



5. Do questions 5, 6, 7, 8, 9, and 10. (b) of Further Analysis on page 337 of your text.

   Textbook question 5:

   Textbook question 6:

Textbook questions 7 and 8:

Decision Analysis

Consequence	Duration (S or L)	Magnitude (H, M, L, N)	Probability (H, M, L, N)
1.			
2.			
3.			
4.			

Textbook question 9:

Textbook question 10. (b):

Check your answers by turning to the Appendix, Section 6: Activity 2.

In this section you have used a process for resolving personal and societal issues. Whenever you are solving a personal or societal issue, you should apply the methods you have learned.

When you looked at the problems facing Rapid Steps, you had to identify issues, identify alternatives, research, reflect and decide, and then take action. After all this has been done, it is time to evaluate the decision-making process.

6. How effective was the decision-making process you used?

Check your answers by turning to the Appendix, Section 6: Activity 2.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

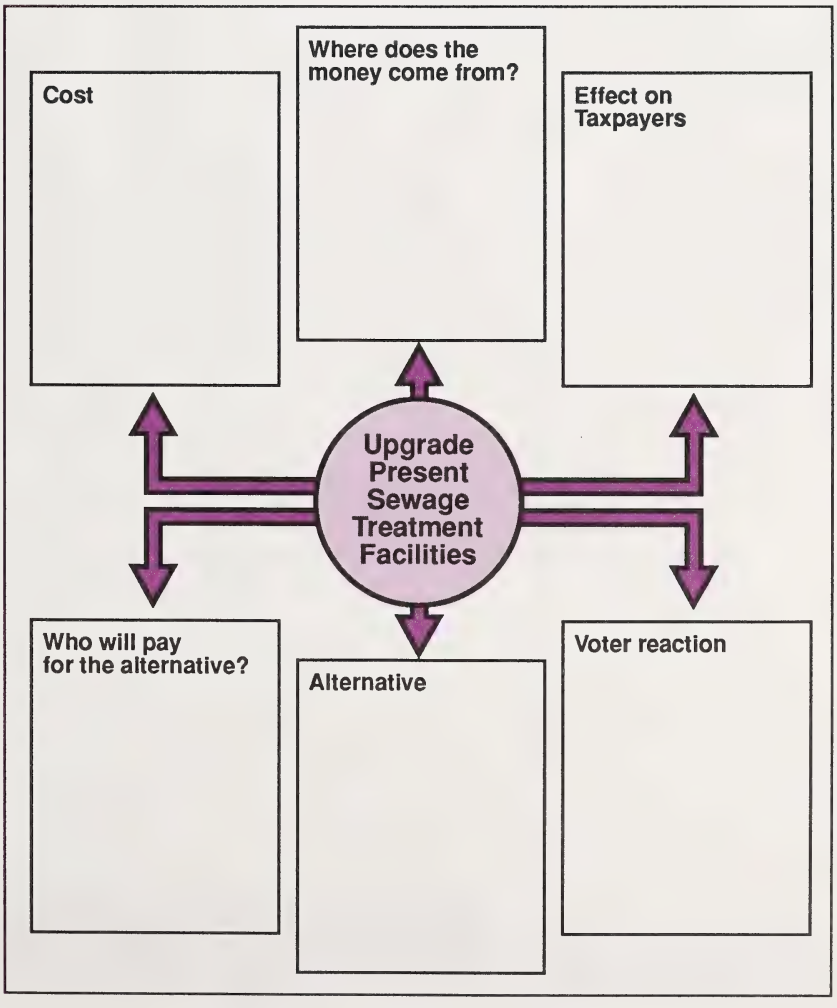
Extra Help

In this module you prepared for a presentation at a public hearing. One way to gather your thoughts on a topic is to use a technique called "clustering". In clustering, you place the important idea or topic in the centre and connect other ideas to it. After you have gathered your ideas, you can organize them into one or more paragraphs.

9 Science Directions

Refer to page 334 of your textbook.

1. Take the role of a city council member and cluster ideas for your presentation. Indicate the point in the labelled circle.



2. Prepare a two minute presentation by organizing your ideas from the previous question.

Check your answers by turning to the Appendix, Section 6: Extra Help.

Enrichment

Do either Part A or Part B, or both.

Part A

Research information about a current public environmental hearing in a newspaper, newsmagazine, or some other form of media.

1. Determine the issue.

2. What major viewpoints are expressed?

3. What evidence is there that science has played a role in this hearing?

End of Part A

Discuss your answers with your learning facilitator.

Part B

Attend a local public environmental hearing.

4. Take the role of a reporter and prepare a news report on what you learned at the hearing. Include the following necessary information:

    - What is the issue?
    - What are some of the viewpoints?
    - How is science playing a role in the societal decision?

End of Part B

Share your answer with your learning facilitator.

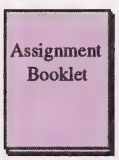
Conclusion

In this section you learned how to use a decision-making process to resolve an environmental issue. There will be many times in your future where this process can be used for solving other personal and societal problems. You may also find that scientific methods can provide valuable information to support your viewpoints or help you evaluate decisions that you have made.

There is no assignment for this section. Read the Module Summary before continuing with the Final Module Assignment.

MODULE SUMMARY

In this module you have learned that technological advances can lead to environmental problems. These problems can be examined through scientific methods. However, the solutions to these problems require personal and societal decisions. You were also introduced to the idea of environmental quality and the role of science in monitoring that quality. You had an opportunity to look at the long-term and short-term impacts of human actions within different environments. You were able to examine a sample of water the way that a chemist and an aquatic biologist would, and you played a role in a mock environmental hearing.



ASSIGNMENT

Turn to your Assignment Booklet and do the Final Module Assignment.

Appendix

Glossary

Abiotic factors	• factors that are considered to be non-living
Biodegradable	• something that can be broken down and used as food by living organisms
Biotic factors	• factors that are from the living part of the environment
Effluent	• partially purified waste water which runs into rivers, lakes, or oceans
Issue	• a matter about which people have different viewpoints
Non-biodegradable	• something that cannot be broken down and used as food by living organisms
Population	• the number of people living in a specific area at a specific time
Sewage	• liquid and solid wastes which are usually carried away by underground pipes
Sludge	• the material that settles out of sewage during the primary sewage treatment
Solid waste	• a type of litter, trash, or garbage which accumulates in large quantities
Stakeholder	• a person that has something to gain or lose, depending on the decisions made about a particular issue
Turbid	• cloudy or unclear
Urbanization	• the trend of movement towards urban areas
Waste	• anything considered to be useless

Suggested Answers

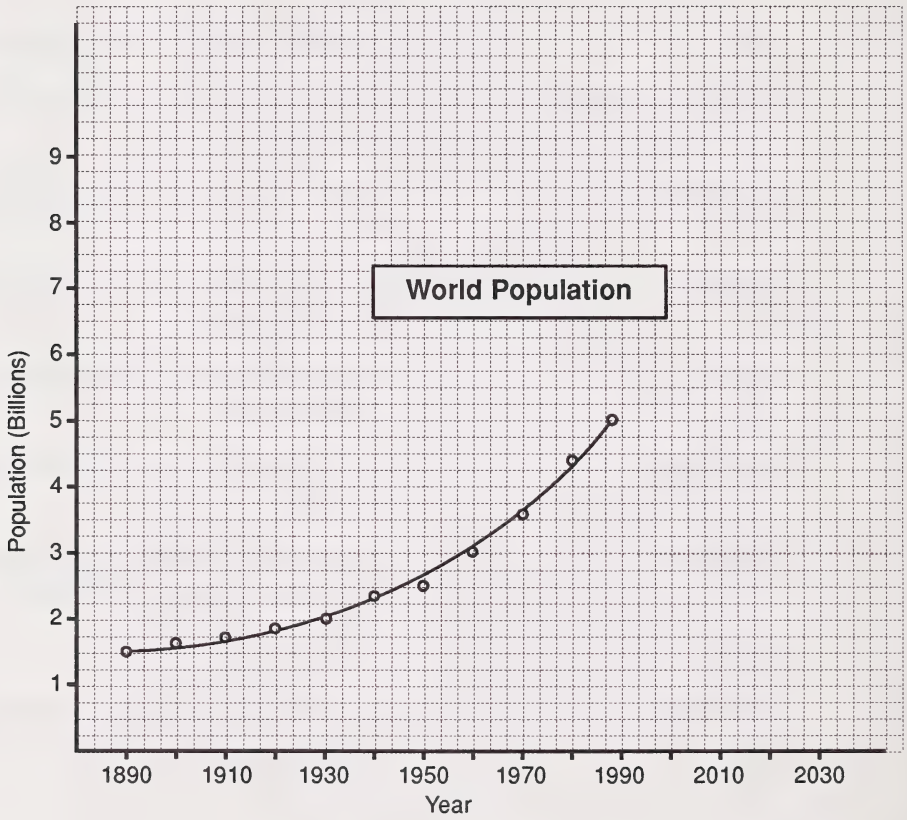
Section 1: Activity 1

1. They discovered how to use the energy stored in fuels such as coal and water.

2. Earth's population has increased from 1.5 billion in 1890 to 5 billion in 1990. Earth's population is doubling in only thirty to thirty-five years!

3. How is the world population changing?

4.



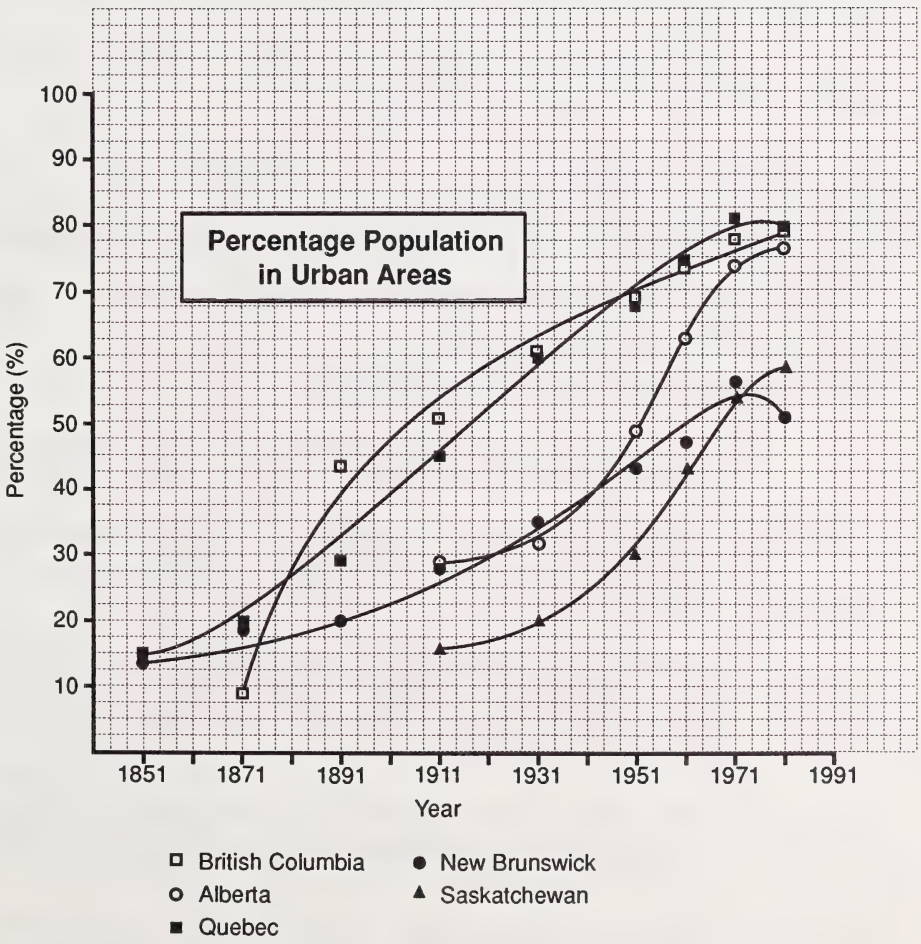
5. You may predict that the trend will continue and cite reasons such as improved health care, better sanitation, and improved food distribution systems. You may predict that the trend will not continue and cite collapse of the global economy, disasters, or even the AIDS epidemic as reasons for the population growth to cease.

6. You may suggest widespread famine, war, new diseases, or birth control as reasons leading to population decrease.

Section 1: Activity 2

1. The first factor was the discovery that microorganisms cause disease. This led to more sanitary conditions, improved medical treatment, and improvements in food production. The second factor was the development of industrialization through the invention of machines that improved production and transportation.

2. The shape of the lines on the graph will vary, depending on which five provinces were selected from Table 6-2 in the textbook.



3. All provinces show a general increase in the percentage of urbanization over the time period recorded. British Columbia had the greatest urbanization in the early part of this century, while Alberta and Saskatchewan have had the greatest urbanization in the last thirty years.

4. The trend is for more people to move to the cities (urban areas) as time passes.

5. The general trend is towards urbanization. This trend will continue. A contributing factor is that farm equipment allows an individual to farm a much larger area now, as compared to the pioneer days. This means that it takes fewer farmers to farm large areas of land. A second factor is that farming has not been very profitable in recent years.

6. Percentage allows comparison. Raw data would not provide meaningful information which could be used for comparison.

7. Urbanization is the trend of movement towards urban areas.

8. The two major impacts of a city are a large daily input of materials and energy and a large daily output of wastes.

Section 1: Activity 3

1. An issue is a matter about which different people have different viewpoints.

2. Concern that knowledge is obtained by objective observation and scientific experimentation makes an issue science-related.

3. Answers may vary. Some examples are given.

   a. ecological: Oil and gas development disturbs or destroys wildlife. Oil and gas companies should be restricted from drilling in areas that contain rare plants and animals.

   b. economic: The oil and gas industry provides a lot of jobs both directly and indirectly. If they don't drill here, they will go elsewhere and take the jobs and the economic growth with them.

   c. ethical/moral: It is not right that plants and animals will have their habitats ruined by the action of the oil and gas industry. You may also state that it is not right that many people will be left jobless because the concerns of a few people for a few plants and animals prevent the drilling projects.

   d. health-related: The peace and quiet of the natural areas will be disturbed by the action of the oil and gas industry and people will no longer be able to get rest and relaxation from visiting such areas.

   e. political: Many jobs are related to the gas and oil industry. These jobs are represented by voters whose interests must be served before the interests of the wildlife.

4. A viewpoint is neither right nor wrong. It must be considered in terms of where it is coming from.

Section 1: Follow-up Activities

Extra Help

Column A		Column B
a. ecological b. economic c. recreational d. political e. scientific	___c___	This is the last long weekend of the summer and the last chance many people get to go camping before winter.
	___e___	The bears need to move into the valleys to feed. This allows them to prepare for the winters hibernation.
	___a___	The bears belong in that environment and the campers are the intruders. Campers should be kept out.
	___b___	If the campground is closed, the local store will have to lay off four of the seasonal workers before the long weekend. The workers were counting on the extra wages to pay for tuition at college next year.
	___d___	If the campground closes, the Minister of Recreation and Parks will receive a lot of angry letters and phone calls.

Section 2: Activity 1

1. Solid waste is a type of litter, trash, or garbage which accumulates in large quantities.

2. On average, each Canadian produces more than 400 kg of household garbage per year.

3. On average, each Canadian produces just over 1 kg of solid waste per day (400 kg/year ÷ 365 days/year = 1.09 kg/day).

Section 2: Activity 2

1. A sanitary landfill site is where incoming waste is compacted to reduce its bulk and covered over with soil to prevent the spreading of litter and chemicals.

2. Biodegradable wastes can be broken down and used as food by living organisms. Non-biodegradable wastes cannot be broken down and used as food by living organisms.

3. Landfill sites are chosen to avoid the possibility of any toxic wastes entering the water supply by seeping into ground water.

4. The materials are not dangerous in the home, but when they are discarded they can dissolve in water and be carried elsewhere. Cadmium is the example given in your textbook.

5. These chemicals may enter the food chain. Animals at the top of the food chain, including humans, may be affected.

6. Your answers should contain the four Rs of waste management. These include reducing, reusing, recycling, and recovering.

Section 2: Follow-up Activities

Extra Help

1. a. reduce: to decrease the amount of wastes produced. The simplest way to reduce is to look for packaging that is not excessive.

   b. reuse: to use things for the same purpose more than once or to use them for a new purpose. Refillable canisters can be used to store bulk foods, rather than buying pre-packaged foods.

   c. recycle: to collect wastes of a certain type so that they can be broken down and rebuilt into a new product. Bottles can be used to produce stucco.

   d. recover: to reclaim waste material or energy and to put it to another use. Waste industrial heat can be used to heat a greenhouse.

Enrichment

Answers may vary. You might suggest a blue box system for the school or the neighbourhood, if these are not already in place. You might also come up with new ideas on the problems related to packaging.

Section 3: Activity 1

1. Earth carries its own air and other supplies and its inhabitants depend on the recycling of materials within it.

2. It was not until the 1800s that coal smoke and fog led to problems in major industrial cities. A word which resembled a combination of smoke and fog was needed to describe these problems.

3. Textbook question 1:

Polluting Gas	Major Source
carbon monoxide	vehicle exhaust
nitrogen oxides	vehicle exhaust
sulphur oxides	industrial processes
hydrocarbons	vehicle exhaust
particulates	industrial processes

Textbook question 2:

Vehicle exhaust is the greatest source of pollution.

Textbook question 3:

Forest fires seem to be a major natural source of these gases.

Textbook question 4:

Answers may vary. Any answer which suggests a reduction in vehicular traffic is acceptable. Your suggestions might include the following: provide efficient and rapid public transit; encourage gas efficient vehicles through taxation or licensing; reduce the amount of parking available in an area, forcing public transit or car pools.

Section 3: Activity 2

1. Sulphur and nitrogen oxides produced by ore smelters, coal-fired electrical generating stations, and paper mills are the two main pollutants that cause acid rain.

2. Acid rain has a pH lower than 5.6.

3. • Acid rain causes chemical changes in soil and water that can reduce soil fertility, retard tree growth, and kill animal and plant life in lakes.

   • Acid rain can corrode exposed metal surfaces and eat away stone statues and limestone buildings.

   • Acid rain can result in the leaching of toxic chemicals, such as mercury, from the soil into the waterways.

4. In some areas limestone underlies much of the land. Limestone neutralizes acids. In other areas the bedrock is mostly granite and cannot neutralize acid rain. As a result, these type of areas become increasingly acidic.

- Emissions of sulphur dioxide have been reduced by the development of tall smokestacks that dilute emissions and by the introduction of scrubbers that remove the emissions.
- Air pollution has been reduced by the use of fuels which contain less sulphur, such as natural gas or alternate forms of fuel.
- Air pollution has been reduced by stricter controls on automobile emissions, such as the catalytic converters required by law since the 1970s.

Section 3: Activity 3

1. Pollutants generally enter lakes and rivers through the following ways:

   - Pollutants enter waterways indirectly from solid and gaseous wastes.
   - Pollutants are carried through ground water to waterways.
   - Pollutants are carried through the air from the burning of fossil fuels.
   - Pollutants are added directly through waste water.

2. a. sewage: liquid and solid wastes which are carried by underground pipes

   b. effluent: partially purified waste water which runs into river, lakes, or oceans

   c. sludge: the material that settles out of sewage during the primary sewage treatment

3. a. primary sewage treatment: done by physical processes. Filtering or sieving is followed by settling.

   b. secondary sewage treatment: done by biological processes. The waste water is held in tanks where bacteria and other microorganisms decompose much of the biodegradable waste.

   c. tertiary sewage treatment: done by chemical processes. These treatments are designed to remove dissolved nitrates, phosphates, and remaining suspended undissolved solids from the effluent.

Section 3: Follow-up Activities

Extra Help

1. Vehicle exhausts are the greatest source of pollution on three of the graphs.
2. Forest fires are the natural process found on three of the graphs.
3. Vehicle exhaust is contributed to directly by individuals.

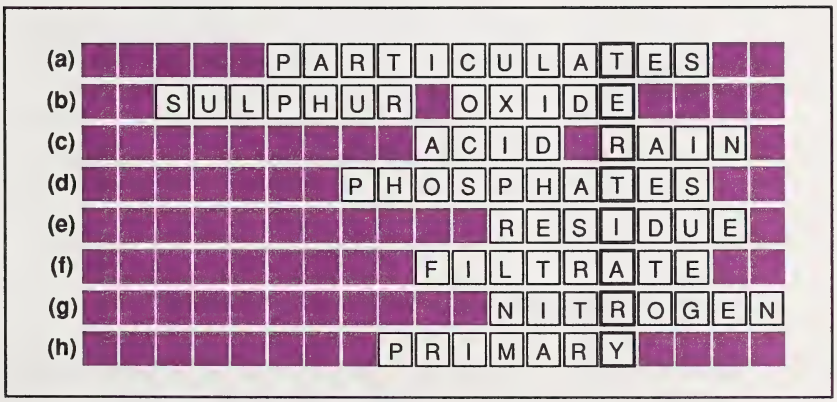
4. Answers may vary, but you may feel that restrictions on vehicles would be the easiest.

5.

Column A	Column B
a. disease-causing agents	___d___ agriculture, forestry, mosquito control
b. carbon compounds	___a___ poorly treated domestic sewage
c. water-soluble acids and salts	___b___ paper-making plants
d. water-soluble poisons	___g___ uranium mining
e. plant nutrients	___e___ food-processing industries
f. sediment and suspended undissolved matter	___h___ electrical power plants
g. radioactive substances	___c___ irrigation
h. heat (from water used as a coolant)	___f___ construction

Enrichment

1.



Hidden word: tertiary

Definition: the level of sewage treatment in which chemicals are used to remove nitrates, phosphates, and remaining suspended solids

2. Answers will vary. Your paragraph should include the information comparing the type of bedrock found in the area with the pH of the rain that is received by that area. Air flow patterns will also determine what regions receive acid rain, even though they may be some distance away form the source of the pollutants.

Section 4: Activity 1

1. Large amounts of water must be used to wash the excess soil off of the carrots. In addition, carrots were dipped into a strong solution of lye to loosen the skin. The lye and loose skin then had to be washed off.

2. The problem was how to remove the skins and lye from the carrots without using so much water. A huge amount of water was used to wash the lye from the carrots. This effluent had to be treated before it could be returned to the environment.

3. Carrots retain nutrients that would have otherwise been rinsed away in the water. Ten percent more of the carrot is saved by this process.

4. Answers will vary. Sample answers are provided.

    a. potato chip producer: "My plant used to cause a lot of waste water which overloaded the city's treatment plant. We now save money by recovering the dried wastes and oil. Our effluent is much cleaner than before."

    b. mayor of the city: "Our treatment plant was overloaded and it would be expensive to build a bigger plant. By cooperating with the producer and the farmers, we have saved the jobs at the plant and have saved the taxpayers the cost of upgrading the treatment plant."

    c. local farmer: "We are able to buy a cheaper feed for our hog production. This has allowed us to increase profit. At the same time, we have continued to have a market for our potato crop."

Section 4: Activity 2

1. Answers will vary. You may have given answers such as drinking water, personal cleanliness, and recreation (boating and fishing).

2. a. The current population of Rapid Steps is 300 000.

    b. In twenty-five years the population will be 600 000.

3. The drinking water is cloudy and sometimes tastes bad.

4. Your answers may vary. Possible answers include having to answer to evidence that the city is to blame for the problem. Also, installing additional equipment is expensive and taxes will have to increase.

5. Tax money is also required for new sewer pipes, new water pipes, new gas lines, road improvements, school maintenance, and city maintenance.

6. The fertilizer plant has the choice of cleaning up at a cost that might force them to close down, or having the city do the cleanup for a fee.

7. If the people of the city used phosphate-free detergent, maybe there would be no need for the expensive changes and the local detergent plant would profit.

8. The farmers along the river could change their practices and build holding basins to prevent runoff from entering the river.

Section 4: Activity 3

1. turbid: cloudy or unclear

2. The secondary treatment is supposed to remove the material which does not settle out.

3. It is important to know what the water is like prior to the sewage treatment plant. These samples can be used as an experimental control. The changes below the plant may then be attributed to the plant.

4. Textbook question 1:

   If the particles are larger than the pores in the paper, then the particles will not pass through the paper.

   Textbook question 2:

   Sewage, industrial waste, and eroded substances are the sources of the suspended solids.

5. There are more upstream sources of solids as you move downstream.

6. The calmer water here might allow some solids to settle to the bottom. There may also have been a difference in sampling techniques.

Section 4: Activity 4

6. Textbook question 5:

   Phosphates enter the surface water from sewage or from the runoff from fields which contain fertilizer or manure.

Textbook question 6:

It is important to know if the phosphate has been removed from the treated water to determine whether the treatment has been successful.

7. Textbook question 1:

The largest changes in concentration of phosphates occur between Sites 1 and 2 and between Sites 4 and 5.

Textbook question 2:

The greatest source is the sewage plant since the greatest increase of phoshates was between Site 1 and Site 2, but the fertilizer plant and the local farms and ranches also lead to an increase in the phosphates, as indicated by the data results at Sites 3 and 4.

Section 4: Activity 5

1. a. abiotic factors: factors that are non-living parts of the environment

   b. biotic factors: factors that are from the living part of the environment

2. Most organisms require more than 5 milligrams per litre (5.0 mg/L) of oxygen.

3. For every litre of water (solvent) there is a milligram of the material (solute). In this case the solute is oxygen.

4. Answers will vary. Compare your data to the results provided in question 5.

5. The data represents the average oxygen content of three water samples in the following situations:

Sample	Dissolved Oxygen (mg/L)
1. tap water	**varies from 6 – 10**
2. boiled water	**zero**
3. boiled, cooled water	**zero**
4. sample 3, shaken	**varies from 2 – 6**
5. sample 3, shaken again	**varies from 4 – 8**
6. sample 3, shaken third time	**varies from 6 – 10**

6. The higher the temperature, the less dissolved oxygen it can hold.

7. Increased turbulence increases the oxygen content of the water.

8. Textbook question 4. (a):

   This question could be answered in several ways. You might indicate the season of the year or the temperature of a specific day as something that would change the water temperature. Large factories may discharge warm effluent into the river. If the speed of the running water is slowed down by something like a dam, the water will be warmed by the sun.

   Textbook question 4. (b):

   As the water warms up, some of the animals may die because of a decrease in the dissolved oxygen content.

   Textbook question 5:

   Rapids, waterfalls, or even some large rocks in the water will help to oxygenate the water. Water plants and algae are the most important sources of oxygen. They release oxygen during photosynthesis.

9. Textbook question 1:

   The oxygen concentration shows a decrease at Sites 2, 3, and 4.

   Textbook question 2:

   The most likely source of pollution is the sewage treatment plant which discharges biodegradable sewage into the river. As the sewage decomposes, oxygen is used up. To a lesser extent, the fertilizer plant and the farms and ranches are also sources of pollution responsible for the decrease in the dissolved oxygen content in the Rapid River.

Section 4: Follow-up Activities

Extra Help

1. The carbon dioxide escapes into the air.

2. It is easier to dissolve a gas in cold water.

3. The oxygen escapes into the air.

4. If the water warms up or if there is an increase in the amount of biodegradable solids in the water, the amount of dissolved oxygen will decrease.

5. Answers will vary. Increased turbulence will add some oxygen, but the greatest contribution is made by water plants and algae that produce oxygen during photosynthesis. However, too many plants or too much algae is also dangerous. They will decompose after they die and this will remove oxygen from the water.

Section 5: Activity 1

1. Water that is polluted will generally have fewer kinds of organisms than similar amounts of clean water.

2. This is a living organism which can be used to give information about the environment.

3. Answers will vary. Sample answer: It is possible to use certain organisms as biological indicators because they will grow only in water with an adequate amount of oxygen.

4. Answers may vary. You may argue that a chemical indicator is more accurate because the standards can be repeated, or that the biological indicators may be unreliable because other factors may influence their tolerance in that environment.

Section 5: Activity 2

1. Textbook question 1:

   Answers may vary. Compare your results with those in Table 6-5 on page 330 of *Science Directions 9.*

   Textbook question 2:

   Answers may vary, but there should be a correlation with the answer obtained with the dissolved oxygen kit.

   Textbook question 3:

   If the two answers are not in agreement, the variation is most likely in the counting and classification of the organisms.

   Textbook question 4:

   Answers may vary, depending on the sample.

   Textbook question 5:

   Sources of error can be in both the chemical indicators and in the biological indicators. The identification of the insect larvae probably represents the greatest source of error for students.

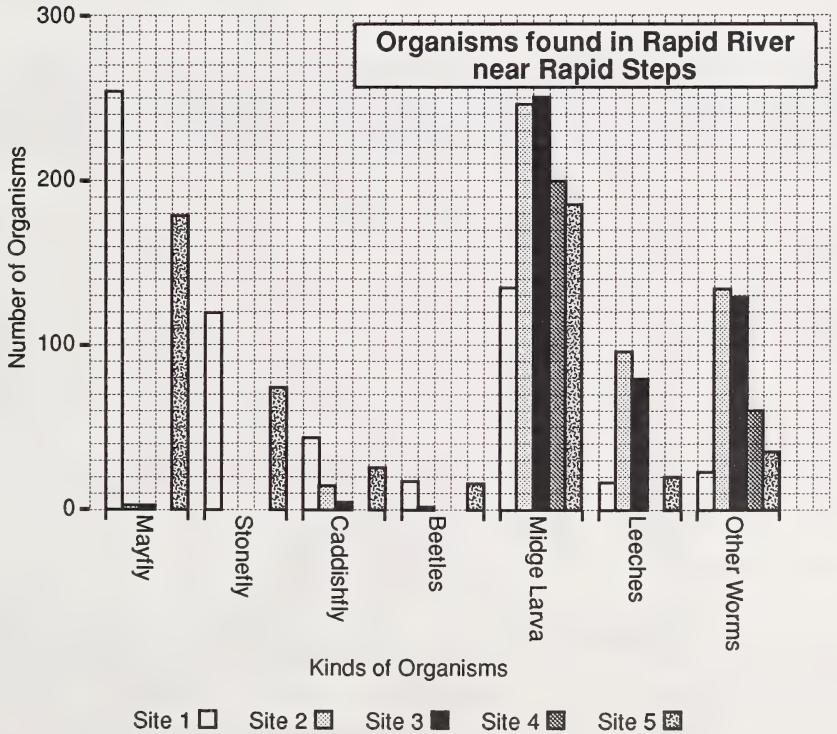
2. • Use a net and a shovel to scoop organisms from the bottom after stirring up the mud.
   • Store the organisms in a bucket of fresh water from the stream.
   • If you are unable to examine the organisms for 24 hours or more, preserve them in a 70% ethanol solution.

3. • Place a sample of the water in a petri dish.
   • Examine and identify the types of organisms present.
   • Count the number of each type of organism and tabulate your data.

4. The presence of a large number of beetles and a variety of fly larvae indicates excellent oxygen levels.

5. Textbook question 1:

   Comment: There are other ways that this graph may be plotted. This is presented as a sample solution only.



   Textbook question 2:

   The loss of midges and the gain of worms indicates that there must be a decrease in dissolved oxygen content.

Textbook question 3:

As the dissolved oxygen content changes, so do the amounts and kinds of different organisms.

Textbook question 4:

Yes, there is a correlation.

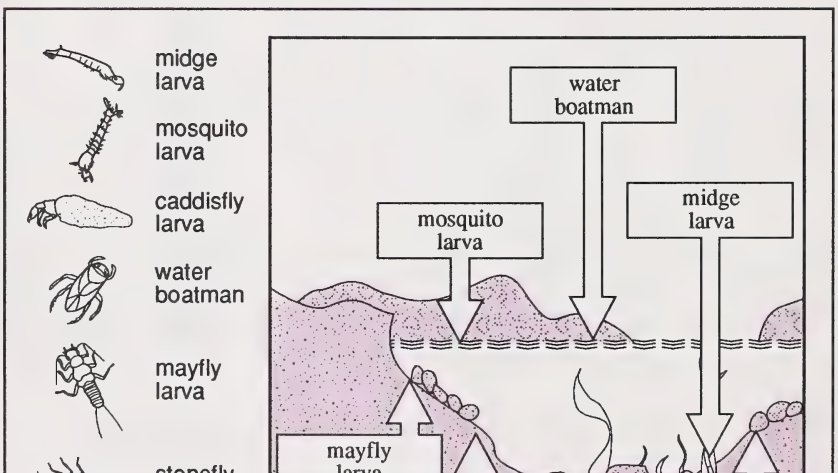
Textbook question 5:

Dissolved oxygen is in the excellent range at Site 1. Below the sewage treatment plant, there is a definite drop in dissolved oxygen. This drop continues past the fertilizer plant. There is also an indication that there is a loss of dissolved oxygen due to the farm runoff. At Site 5 there is an increase in dissolved oxygen content, which may result from the water entering the river from the stream at Bridgeland or increased plant growth below the fertilizer plant.

Section 5: Follow-up Activities

Extra Help

1.



2. Leeches will grow where there is a high dissolved oxygen content or where there is a low oxygen content. If there are ten times as many Caddisfly larvae or Mayfly larvae as leeches, then the dissolved oxygen content is excellent. If there are no Caddisfly larvae or Mayfly larvae then the dissolved oxygen content could be low or very low. One organism by itself cannot be an indicator.

Enrichment

1. Answers will vary greatly, depending on the organism chosen. However, all insects will go through a metamorphosis which should be noted in the description.

2. Answers will vary. The answer to this should include the method that the organism uses to increase the surface area for exchange and/or the flow of water over the surface.

Section 6: Activity 1

1.

Role	For/Against/ Neutral	Viewpoint	Summary of Reasons
city taxpayer	against	egocentric/economic	Taxes are high already. We pay to clean water; other communities should pay to.
city council member	against	economic/political	Money is needed elsewhere. Who would vote for raised taxes?
manager of detergent factory	against	economic	Phosphate-free detergent would help solve the problem.
worker from plant	for	economic	That is where I can find a job.
manager of fertilizer plant	for	economic	If city does it, we can use the upgrade and save doing it ourselves.
representative for towns of Bridgeland and Springford	for	egocentric/economic	Our small towns cannot afford to clean up after you. Our water tastes bad and it's your fault.

Role	For/Against/ Neutral	Viewpoint	Summary of Reasons
sewage treatment technologist	neutral	scientific	It can be done, but it is expensive.
agricultural researcher	neutral	scientific	Phosphates and nitrates come from agricultural sources, also. These can be cleaned up in other ways.
local teacher	for	recreational	The river is not what it used to be 10 years ago.
member of local environmental group	for	ecological	We must keep the river safe for all species.
fishing guide	for	economic/recreational	I don't get as many fishing parties as I used to.
freshwater biologist	against	scientific	These are the results of water analysis.
farmer/rancher	for/neutral	egocentric/economic	It is easier for the city to clean up than for individual farmers/ranchers to change.

2. Answers may vary. Sample answers:

   To: manager of detergent factory

   Question: Does your manufacturing process create any additional wastes if you make more of your product?

   To: sewage treatment technologist

   Question: What happens to the aluminum sulphate or magnesium sulphate? Doesn't that lead to pollution as well?

   To: fishing guide

   Question: Why don't you just move upstream from the city?

Section 6: Activity 2

4. Textbook question 1:

   Answer may vary. Your answer must be consistent with the previous answers in this section.

   Textbook question 4. (a):

   The city is the greatest source, but the fertilizer plant and the farms and ranches also contribute to the phosphate pollution problem.

   Textbook question 4. (b):

   Answers may vary. Sample answer:

   The city must spend the money to upgrade the sewage treatment plant.

5. Textbook question 5:

   Individuals can make a difference if they participate in the process in a meaningful way. Individuals can also work with others to form interest groups with greater influence.

   Textbook question 6:

   The main point of your paragraph should be that science played a role by providing the data on which the decision was based.

   Textbook questions 7 and 8:

   Answers will vary. The purpose of these questions is to show the types of evaluations that must be made with any possible solution.

   Textbook question 9:

   Answers may vary. It is possible that you might alter the original decision after considering these additional consequences and their importance.

   Textbook question 10. (b):

   Answers will vary. Sample answer:

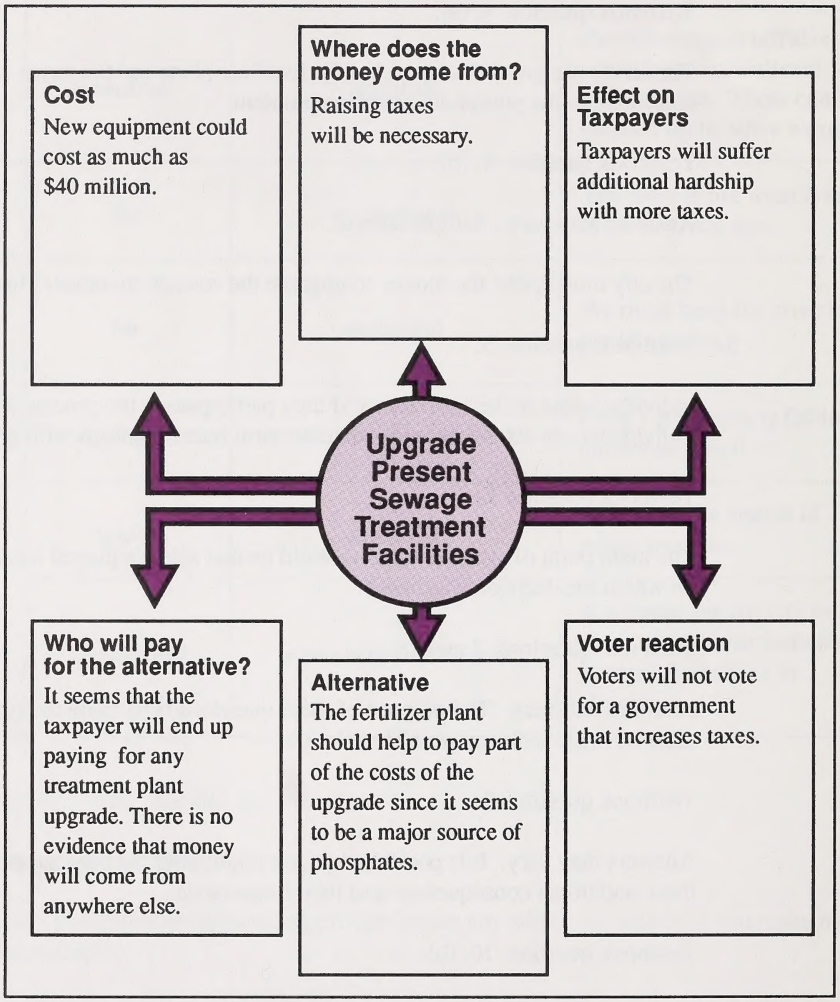
   Phosphate-free detergent could be the only detergent sold in the stores.

6. You should now appreciate that decisions regarding environmental quality are needed, and that the process should be informed by knowledge of environments and objective assessments of environmental impacts.

Section 6: Follow-up Activities

Extra Help

1. Answers will vary. Sample answers:


Cost
New equipment could cost as much as $40 million.
Where does the money come from?
Raising taxes will be necessary.
Effect on Taxpayers
Taxpayers will suffer additional hardship with more taxes.
Upgrade Present Sewage Treatment Facilities
Who will pay for the alternative?
It seems that the taxpayer will end up paying for any treatment plant upgrade. There is no evidence that money will come from anywhere else.
Alternative
The fertilizer plant should help to pay part of the costs of the upgrade since it seems to be a major source of phosphates.
Voter reaction
Voters will not vote for a government that increases taxes.

2. Answers will vary. You should now take the ideas clustered in the previous question and combine them into a paragraph.

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